



**Technical University of Lisbon
High Institute of Management and
Economics**

**Through Mountains and Valleys – Innovation,
entrepreneurship and growth**

Vítor Hugo dos Santos Ferreira

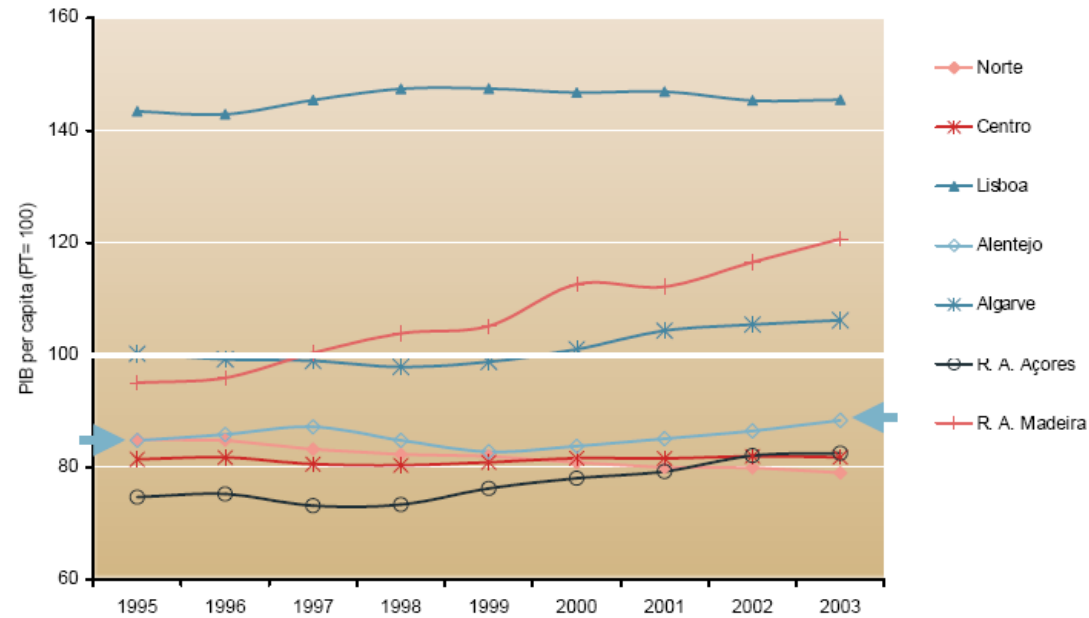
Structure:



1. Research Idea
2. Knowledge, Growth and Innovation
3. Spillovers and New Growth Theory
4. Entrepreneurship and Knowledge
5. Theoretical Model
6. Empiric Model and Data
7. Findings
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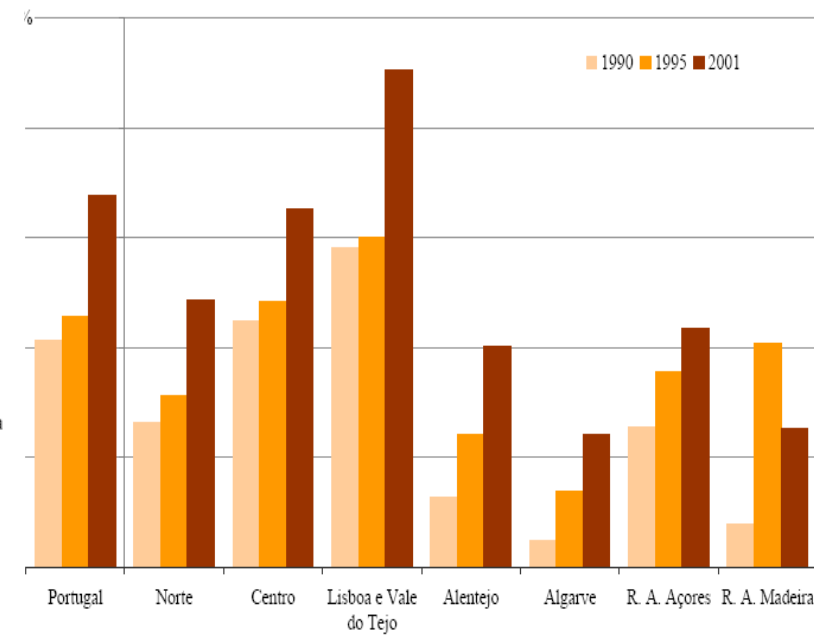
Motivation: Mountains and valleys?

Evolution of regional per capita GDP 1995-2002



Source: Mateus (2006)

R&D Intensity – Portuguese Regions



Source: Laranja (2006)



- Which factors can explain regional growth?

New Growth Theory



- Robert Solow (1957) developed a neoclassical model of growth, which allowed discerning the influence of exogenous factors, explaining per capita growth above what would be expected through re-investment of capital. This growth results from what became known as the residue of Solow and understood as a measure of technological change during the period under review (Harris and Kells, 1997).
- New Growth Theory (NGT), Romer (1986,1990) e Lucas (1988) builds upon the previous notion and is based on two very important aspects:
 - technological progress can be seen as **something** endogenous, a product of economic activity
 - unlike physical capital, knowledge and technology generate increasing returns to scale
- Central role of Knowledge => investments in human capital and knowledge generate economic growth, not only from the production factors, capital and labour, which are more productive, but also in an indirect way through Knowledge "spillovers".

Spillovers in the NGT



- These models emphasize that knowledge has almost public good characteristics. Therefore, this knowledge will generate benefits not only for those who apply it in the form of an innovation, but also for others through "spillovers".
- Citing only some recent empirical studies (Plummer & Acs, 2004; Varga & Schalk, 2004; Acs & Varga, 2004; Audretsch & Keilbach, 2004) we find that knowledge "spillovers" positively affect technological progress and economic growth.
- The knowledge "spillovers" are key elements in the transfer of knowledge from industry to industry (Romer 1986.1990; Acs and Plummer, 2005).
- The NGT models assume that these "spillovers" are almost automatic, without cost and not limited by geography (Acs, 2004) (vide entanglement).

The nature of Spillovers



- Little evidence of the automatic => "spillovers" tend to be limited by geography, by cost and by legal restrictions (Anselin et al. 1997, 2000; Cohen et al. 2000, Jaffe 1989, Jaffe et al. 1993, Cohen, Nelson e Walsh, 2002; Langlois e Roberstson, 1996, etc.)
 - "Sticky" Knowledge => tacit, transaction costs and perception failure;
 - Geographikly bounded (Acs e Varga 1997 e 2000; Manski, 2000; Agrawal 2002, etc.);
 - some authors even consider that the impact of knowledge "spillovers" is limited to specific distances that can be measured (following Anselin et al., 1997 and 2000; Keller, 2002, we have an impact that reaches between 50 and 75 miles from the point where knowledge was created).

Technology, Innovation and Entrepreneurship



- The key between having knowledge and achieve a return from this knowledge depends of the application on the market. But how to measure technological progress?
- Measures of technological progress:
 - (1) *input measure* - R&D and labour
 - (2) intermediate measure - patents
 - (3) output measure - surveysBut...
- R&D is an *input* to the innovation process(Acs e Audretsch, 2005).
- Patents - very used...
 - Intermediate Measure – quantify new technological knowledge but not if that knowledge has economic value (Acs e Audretsch, 2005).
 - Patents are used as strategic variables
- Finally, we note that many studies aimed at measuring directly innovation (identifying them directly in sectors) ultimately do not count the economic impact of these innovation (i.e., each innovation is considered equal) (Acs and Audretsch, 2005).

Technology, Innovation and Entrepreneurship



- About a century ago Schumpeter (1911) recognized that there was a clear difference between raw knowledge that came from inventor and the one who was boosted by the economic application by the entrepreneur (Schumpeter, 1947).
- The entrepreneur lost its place in the economic sphere, with the big companies playing a more active role in the creation of new knowledge and its translation into innovations, using their scale economies and other advantages (Williamson, 1968; Chandler 1977 and Schumpeter "Mark II," 1942)
- 5 reasons:
 - Scale economies on R&D and on production ;
 - Companies with market power choose innovation as a maximization strategy more often;
 - Larger companies mitigate the innovation risk with diversification;
 - Process innovations that reduce costs have a larger impact on big companies
- So, the R&D effort seems to be linked with the size of a firm (Acs e Audretsch, 2005).

Technology, Innovation and Entrepreneurship



- But since the seventies that there has been an opposing trend, both in the United States and in Europe with some SMEs being the engines of innovation in specific sectors and contributing positively to the aggregate level of innovation.

(Brock e Evans, 1989; Evans 1991; Loveman e Sengenberger 1991; Brown et al., 1990; Acs e Audretsch, 1993)

- There aren't increasing returns to scale on R&D in the production of innovation (with a few exceptions, the decreasing returns are the rule). This fact helps us to solve the apparent paradox, it is true that larger companies have advantages in achieving R&D, but every new euro spent on R&D has an additional increasingly smaller benefit in the generation of innovation.
- There more opportunities for small companies in the knowledge economy.

Technology, Innovation and Entrepreneurship



- Several studies have emphasized the role of innovation in welfare and in growth but only a few chose to link this phenomena to entrepreneurship
- Knowing how small companies generate innovation and the role of new firms in the agregate ecomic growth is very important;
- The first question, the source of knowledge to the smaller companies, seems to be other companies, individuals or universities and other institutions of research (Jaffe, 1990). These companies often seem to take up the knowledge "spillovers" that we mentioned before (and here we also mention a business agglomeration area, because, as we have seen, "spillovers" tend to be geographically concentrated).
- As for the role of entrepreneurship, Audretsch et al. (2006) introduced a new factor of production called entrepreneurship capital, linked to the extensive literature of Social Capital. This capital reflects a number of institutional and social factors (efficiency of the legal system, efficiency of the financial system, cultural aspects).

Technology, Innovation and Entrepreneurship



- Acs et al. (2004), Audretsches and Keilbach (2005) argue that the exploitation of knowledge depends on several factors institutional and regulations, which are in their opinion the “knowledge filter”. This filter is the gap between new knowledge and knowledge that is marketed. Then, the entrepreneurs play a crucial role transforming knowledge into new products and services (i.e. the “spillovers” of knowledge are often enhanced by the work of entrepreneurs).
- Entrepreneurship is a mechanism for the transmission of “spillovers” of knowledge.
- Audretsches and Keilbach (2004b) identified two other forms of entrepreneurship influence in economic growth. The first involves the increased competition, and the second involves the increasing diversity (Glaeser et al., 1992; Feldman and Audretsches 1999; Henderson and Thisse 2004).

Theoretical Model



- Objective – to build a NGT model with entrepreneurship as a mechanism for the exploitation on knowledge

Basic Model



- In this model the function of production for the sector of research activities and for the entrepreneurship sector can be described as it follows:

$$Z_R(L_R) = \sigma_R L_R A \qquad Z_E(L_E) = \sigma_E L_E^\gamma A, \quad \gamma < 1.$$

Knowledge production and technological progress:

$$\dot{A} = Z_R(L_R) + Z_E(L_E) \qquad \dot{A}/A = \sigma_R L_R + \sigma_E L_E^\gamma$$

Basic Model

Researchers and entrepreneurs produce different types of capital goods (X) that are combined with work in the field of production of final goods (Y). Given that balance in the demand for all different types of assets is symmetrical, we can rewrite the equation:

$$Y = (L - L_E - L_R)^\alpha \int_0^A x(i)^{1-\alpha} di$$

$$Y = (L - L_E - L_R)^\alpha A \bar{x}^{(1-\alpha)}$$

Assuming that the capital goods are produced in the same way as other goods and we need to use units of capital goods to produce one unit of capital, we can rewrite the equation of the product:

$$K = \kappa A \bar{x}$$

$$Y = (L - L_R - L_E)^\alpha A^\alpha K^{1-\alpha} \kappa^{\alpha-1}$$

However, if we consider that demand is governed by consumption function with a constant inter-temporal elasticity of substitution, we can maximize the following equation, subject to the restrictions:

$$\max_{C, L_E, L_R} \int_0^\infty \frac{C^{1-\theta}}{1-\theta} e^{-\rho t} dt$$

$$\dot{A} = \sigma_R L_R A + \sigma_E L_E^\gamma A$$

$$\dot{K} = Y - C = (L - L_E - L_R)^\alpha A^\alpha K^{1-\alpha} \kappa^{\alpha-1} - C.$$

We then have the Hamiltonian for the representative consumer:

$$H_C = \frac{C^{1-\theta}}{1-\theta} + \lambda_A (\sigma_R L_R A + \sigma_E L_E^\gamma A) + \lambda_K (\kappa^{\alpha-1} A^\alpha K^{1-\alpha} (L - L_R - L_E) - C)$$

Basic Model

$$L_E = \left(\frac{\sigma_R}{\gamma \sigma_E} \right)^{\frac{1}{\gamma-1}} \quad L_R = \frac{1}{\theta \sigma_R} \left(\sigma_R (L - L_E) + (1 - \theta) \sigma_E L_E^\gamma - \rho \right)$$

$$g = \frac{1}{\theta} \left(\sigma_R L - \rho + (1 - \gamma) \gamma^{\gamma/(1-\gamma)} \left(\frac{\sigma_E}{\sigma_R^\gamma} \right)^{1/(1-\gamma)} \right)$$

As Acs et al. (2005) observe, growth is then given by $g = f(A, R, E, \lambda)$, that is, growth is a function of the stock of existing knowledge, the efforts of research, entrepreneurship and all other factors (λ represents such factors as the capital intensity, institutions, etc.).

Empiric Model

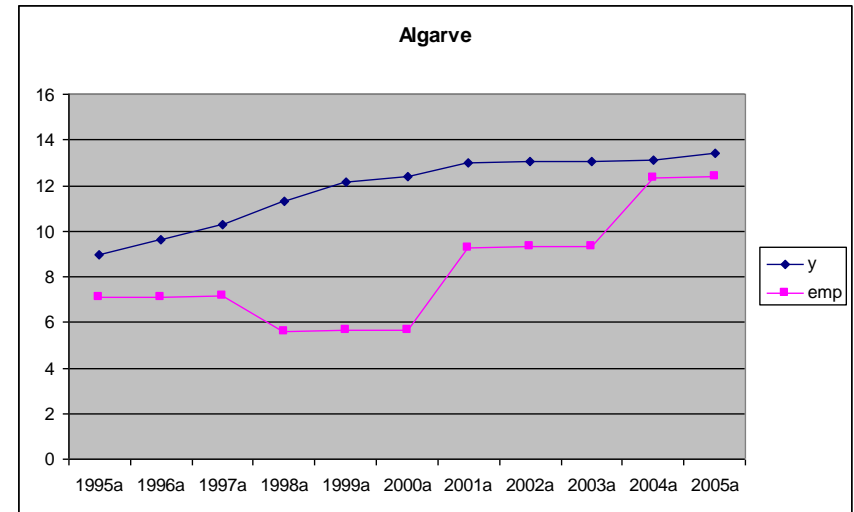
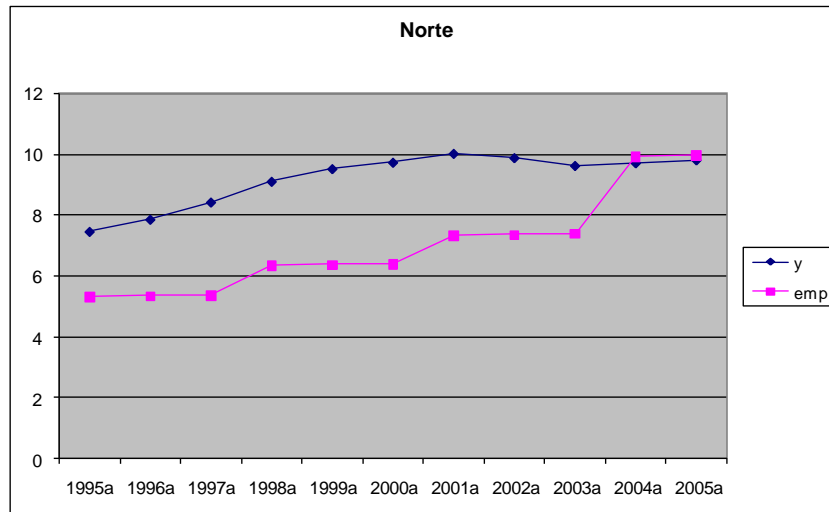


The purpose of this article is to measure the influence of entrepreneurship in regional growth. To do this we will seek to estimate the following function:

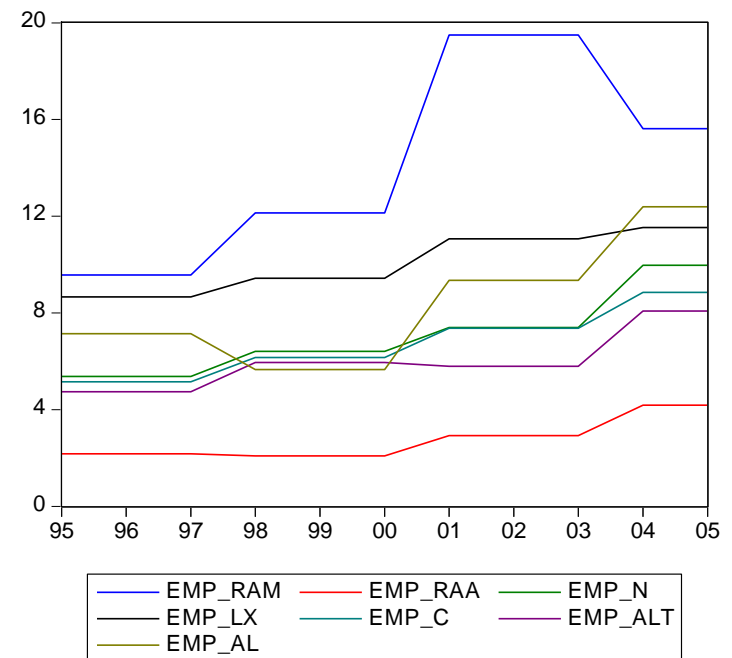
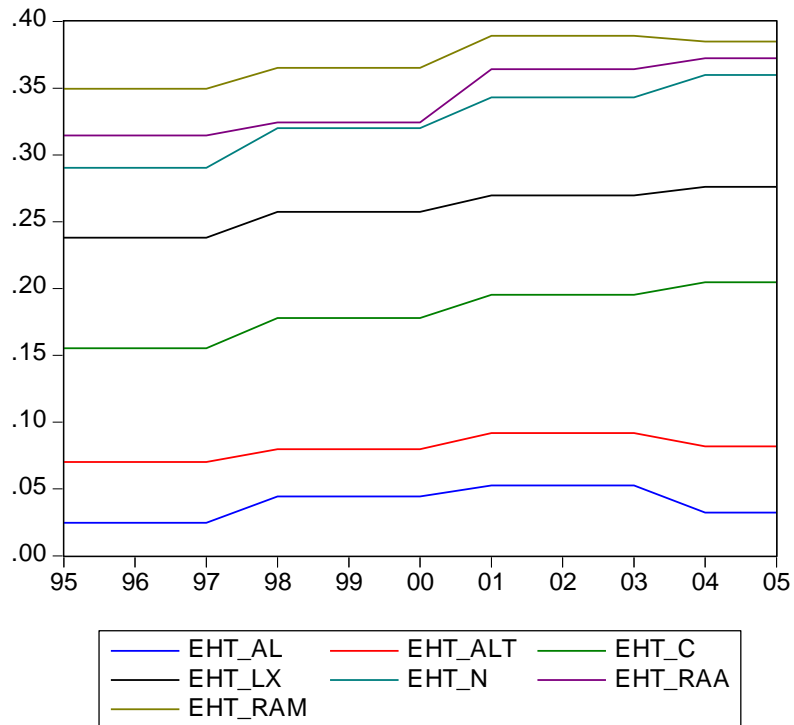
$$g_{i,t} = \alpha_1 + \alpha_2 A_{1,i,t} + \alpha_3 E_{i,t} + \alpha_4 \lambda_{i,t} + \varepsilon_{i,t}$$

- Where i e t refer to the years and regions. The variable (A) is the new knowledge and (E) represents the entrepreneurship. λ represents all other factors that influence economic growth and g is growth rate of GDP of the region.
- To capture knowledge we used two common variables in the economic growth literature, the number of workers in R&D in the region (in relation with the total workforce) (ID) and the average years of schooling of the population over 25 years (ESCOL).
- For entrepreneurship (EMP) we used to the number of new businesses created in a region divided by its population. This rate reflects the inhabitant's ability of a given region to create a new company Audretsch and Keilbach (2004). As the number of new firms creation is subject to a large degree of stochastic disturbance in a short period of time, following Audretsch and Keilbach (2004), we used a 3 years moving average.
- Regarding other variables, following Solow (1957) we tried to incorporate classic regional capitalist intensity (K/L), since the capital stock of each region divided by employment, which is a measure of wealth (or capital-intensity), is also expected to positively impact economic growth.
- Also, following Audretsch and Keilbach (2004) we divided entrepreneurship in low(ELT) and hi-tech (EHT), in order to see if this had an impact on the different results of estimation.
- The dependent variable, Growth (Y), is defined as the annual difference in log real GDP per capita growth (expressed in 2000 prices) for the seven Portuguese Nuts2 regions over the period 1995-2005.
- All data was taken from Eurostat Database and INE Database. The chosen period is provided without breaks in the statistical series (or with the breaks already computed).

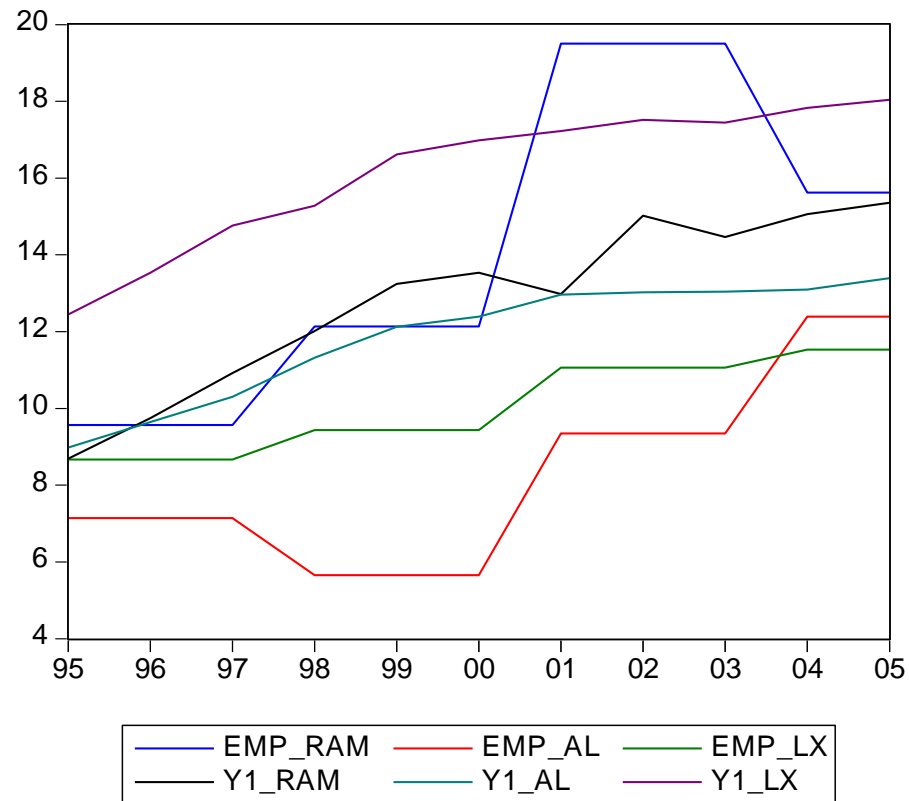
Findings



Entrepreneurship



Entrepreneurship versus Product



Estimation



- Data has been pooled over regions and years for the period 1995 to 2005.
- We performed a Wald test Modified for fixed effects groups, and detected the presence of heteroskedsticity and the Wooldrige Test for panel data and detected Serial autocorrelation.
- Therefore, in the regressions we used a specific generalized least squares (GLS) which controls for heteroskedastic panels (PCSE) and an autoregressive (AR) structure. This structure implies that the error term is serially correlated, such that the current error term partly is a function of previous error terms. An AR1 process means that the current error term depends on just one lagged error term. Also we implemented fixed effects since this was the model that seemed to cope better with non-observable heterogeneity.

Some Preliminary Estimations Results

Dependent Variable: Y?
 Method: Pooled Least Squares
 Date: 04/17/08 Time: 03:23
 Sample (adjusted): 1996 2005

Total pool (balanced) observations: 70
 Period weights (PCSE) standard errors & covariance (no d.f. correction)
 Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.483585	0.269859	5.497624	0.0000
LEMP?	0.042744	0.017341	-2.464832	0.0166
LKL?	0.199210	0.043556	-4.573648	0.0000
AR(1)	-0.259341	0.119389	-2.172233	0.0338
Fixed Effects (Cross)				
_AL--C	0.013459			
_ALT--C	-0.010902			
_C--C	-0.077135			
_N--C	-0.076736			
_LX--C	0.079716			
_RAA--C	-0.021268			
_RAM--C	0.092866			

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.509377	Mean dependent var	0.044138
Adjusted R-squared	0.435784	S.D. dependent var	0.038898
S.E. of regression	0.029218	Akaike info criterion	-4.096524
Sum squared resid	0.051220	Schwarz criterion	-3.775310
Log likelihood	153.3783	Hannan-Quinn criter.	-3.968934
F-statistic	6.921498	Durbin-Watson stat	2.330088
Prob(F-statistic)	0.000001		

Future Research/Steps



- Estimate the model with Nuts3 Regions in Portugal
- Estimate the model for regional growth in Europe
- Divise the role of Entrepreneurship in Urban Growth
- Use of different methods – model with spatial effects and compare with non-parametric approach.



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